XIII. *On the habits of a species of* Ptyelus *in British East Africa.* By S. L. Hinde. Communicated, with Notes, by Professor E. B. Poulton, F.R.S.

[Read June 6th, 1906.]

Plate XIII.

[Mr. S. L. Hinde, in a letter written from Fort Hall, British East Africa, Jan. 12, 1903, gives the following account of the locality and mode of occurrence of an insect which is closely allied to *Ptyelus flavescens*, F., if indeed it is not actually the same species.—E. B. P.]

"I have started a new station, which ought to be a nice collecting ground. It is perhaps 6000 ft. altitude, on the east of Kinangop * and Sattima, *i. e.* Aberdare Range: the bamboo is only about six or seven miles away. The Bamboo Forest is about 9000 to 11,000 ft. altitude. Kenya (17,200 ft.) is about fifty miles away, across the Tana Valley.

"I send you a most interesting insect, which grouped resembles flowers in the imagines and fruit or buds in the larva; it is a cuckoo-spit we found on the banks of the Chania River (where I have placed the new station); the Chania River is a large one, not marked on any map. The insects were on a large tree, perhaps 40 ft. high, and almost every branch was covered with insects, and there was a continuous drip under the tree like rain from their secretions. When within 6 to 10 ft. or more of the insects they looked like flowers and fruit or buds. On the ground there were larvæ and imagines, singly and in groups, that had fallen off the tree. I broke off a branch covered with insects and brought it to the tent. Mrs. Hinde made sketches at once, which we send by this mail. I send you also a box of the insects which have already faded."

*Notes by Professor E. B. Poulton.*

The specimens sent by Mr. Hinde in illustration of his remarks are to be seen in the British Natural History

* In a letter, dated July 2, 1906, from Fort Hall, Mr. Hinde writes:—"Kinangop on many maps, real name Nandarua (altitude 13,000 ft.), is the southern end of the Aberdare or Sattima Range. The insects were found on the Chania River (altitude 5,800 ft.) on the ground that is now Nyeri Government Station, sixteen miles north-east of Nandarua."

Museum and the Hope Department, Oxford University Museum. They were compared by Mr. C. O. Waterhouse and myself with specimens of *Ptyelus flavescens*, F., in the British Museum, and probably belong to this species, allowing for the change of colour described by Mr. Hinde and shown by comparison with Mrs. Hinde's paintings, representing an insect for which *flavescens* would be a most appropriate name.

The locality given on Mrs. Hinde's drawings is Nyeri.

The native name of the tree appears on the drawings as "Muroha." I have sent Mrs. Hinde's careful drawing of it to Kew, and the Director kindly informs me that it is probably a species of *Heptapleurum* (*Araliaceæ*).

Livingstone observed in Angola an insect evidently allied to the *Ptyelus* painted by Mrs. Hinde.* He speaks of it as congregating in small companies of seven or eight on the smaller branches of trees of the Fig family. Such a group would produce three or four pints of fluid in the course of a night. He does not enable us to infer whether many companies inhabit a single tree, but the impression is produced that the numbers are very much less than those described by Mr. Hinde and shown in Mrs. Hinde's drawings. Livingstone believed that the fluid was derived from the atmosphere and not from the tree and made some experiments which appeared to support his opinion. They are however unconvincing, while so improbable a contention demands for its establishment the most incontrovertible of evidence.

Dr. David Sharp, F.R.S., gives the following account of two species with habits somewhat similar to those described by Mr. Hinde:—"In Madagascar it is said that *Ptyelus goudoti* exudes so much fluid that five or six dozen larvæ would about fill a quart vessel in an hour and a half† . . In Ceylon the larva of *Machærota guttigera* constructs tubes fixed to the twigs of the tulip-tree, and from the tube water is exuded drop by drop." (Cambridge Natural History, Insects, Pt. II. London, 1899, pp. 577, 578.) This latter fact is opposed to Livingstone's hypothesis, inasmuch as the tube would tend to hinder contact with the air.

The interpretation of the copious exudation is almost certainly to be found in the relatively small amount of

* "Missionary Travels and Researches in South Africa," pp. 415–417. London, 1857.

† See also Westwood, Introd. Mod. Class. Ins., Lond. 1840, vol. ii., p. 433.

nutriment contained in the sap, so that a great quantity must pass through the body of the insect in order to yield a sufficient supply of food. Analysis of sap drawn direct from the tree as compared with that of the fluid which has passed through the body of the insect might well yield interesting results bearing upon the physiology of insect nutrition.

The frothy covering is a good example of the utilization of an excretory substance for the purposes of defence, entirely analogous to the covering of fæces constructed by many larvæ, the calcium carbonate in the form of minute arragonite crystals rubbed into its cocoon by *Bombyx neustria*, or the hardened paste of calcium oxalate excreted and made use of by the larva of *Eriogaster lanestris*.

Dr. David Sharp (l. c. p. 578) makes the following statement concerning the protective value of the froth :—"The frog-spit is considered by some naturalists to be a protective device; the larvæ are, however, a favourite food with certain Hymenoptera, which pick out the larvæ from the spits and carry them off to be used as stores of provisions for their larvæ." It is strange that Dr. Sharp should quote this observation as if in refutation of the opinion that the secretion is protective. I do not know of a single naturalist, except the late Dr. Haase, who holds or has held that any defence of this kind is effective against all enemies and that universal immunity is thereby conferred. Such a conclusion is unthinkable, and yet it is the only conclusion controverted by Dr. Sharp's statement. The category of special defences to which belongs the covering of froth involves conspicuousness and easy capture by special classes of enemies. But can it be doubted that the adaptation confers nevertheless a balance of advantage in the struggle for existence? The justification of any such doubt requires evidence on a very different scale from that brought forward by Dr. Sharp.

The method by which the froth is produced has been misunderstood and erroneously described probably by every author who has written upon the subject, until it was studied by my friend, Professor E. S. Morse of Salem, Massachusetts. Even his account is but little known by entomologists, because published in a somewhat unusual channel.* The general statement has always been that

* At first in an elementary book on zoology : later in Appleton's "Popular Science Monthly" for May 1900, p. 23.

the *Aphrophora* secretes or emits the froth from its body. Thus Dr. Sharp summarizes the older opinion in the following words:—". . When in the immature stages, certain of them [*Cercopidæ*] have the art of emitting the liquid in the form of bubbles which accumulate round the insect and conceal it" (l. c. p. 577). Professor Morse shows that when the insect is cleared from the bubbles and placed on its food-plant, "it will crawl quite rapidly along the stem . . . , stopping at times to pierce the stem for the purpose of sucking the juices within, and finally settling down in earnest, evidently exerting some force in thrusting its piercing apparatus through the outer layers, as shown by the firm way in which it clutches the stem with its legs. After sucking for some time, a clear fluid is seen to slowly exude from the posterior end of the abdomen, flowing over the body first and gradually filling up the spaces between the legs and the lower part of the body and the stem upon which it rests. . . . During all this time not a trace of an air-bubble appears; simply a clear, slightly viscid fluid is exuded, and this is the only matter that escapes from the insect. . . . This state of partial immersion continues for half-an-hour or more. . . . Suddenly the insect begins to make bubbles by turning its tail out of the fluid, opening the posterior segment, which appears like claspers, and grasping a moiety of air, then turning the tail down into the fluid and instantly allowing the enclosed air to escape. . . . These movements go on at the rate of seventy or eighty times a minute. At the outset the tail is moved alternately to the right and left in perfect rhythm, so that the bubbles are distributed on both sides of the body, and these are crowded towards the head till the entire fluid is filled with bubbles, and the froth thus made runs over the back and around the stem." Many other interesting facts and observations are recorded in this paper which should, I think, be reproduced in a more accessible form, together with the simple but entirely adequate illustrations. The probability of some accessory aid to respiration by means of thin-walled leaf-like appendages is also discussed. The whole problem of the respiration of the insect enclosed in its mass of froth would be a fascinating subject of inquiry. The mere contemplation of it is enough to bring home the utter improbability of the older view as to the origin of the included gas.—E. B. Poulton.

## Explanation of Plate XIII.

The main drawing of the larvæ, etc., on the tree was made from life by Mrs. S. L. Hinde on Dec. 5, 1902. It is reduced to about $\frac{3}{4}$ of the natural size.

The two drawings of the perfect insect with wings expanded and closed respectively and the two drawings of the immature stages were made from life by Mrs. Hinde on Dec. 2, 1902. These are unreduced.